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ABSTRACT

Powerplant systems and procedures that ensure the day-to-day health and safety of people in and around the plant is referred to as operational safety. This safety is the result of careful planning, good engineering and design, strict licensing and regulation, and environmental monitoring. Procedures that assure operational safety at nuclear powerplants are as follows: (1) training and updating of reactor operators in procedures of powerplant operation; (2) maintenance of strict security at the powerplant; (3) control of radiation releases; (4) storage of the spent (used) fuel in deep pools of water within the powerplant to allow cooling and handling of the spent fuel by remote control; (5) certification of powerplants by the Nuclear Regulatory Commission (NRC) in design, construction and safe operation; and (6) ongoing inspections and environmental monitoring programs to ensure that nuclear powerplants comply with all requirements for public health, safety, and environmental protection. Topics discussed include operational safety; personnel training programs; categories of reactor operators; security; control of radiation releases; handling spent fuel; role of NRC; and sources of radiation to the United States population. (RT)

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Nuclear Energy

Nuclear Powerplant Safety: OPERATIONS

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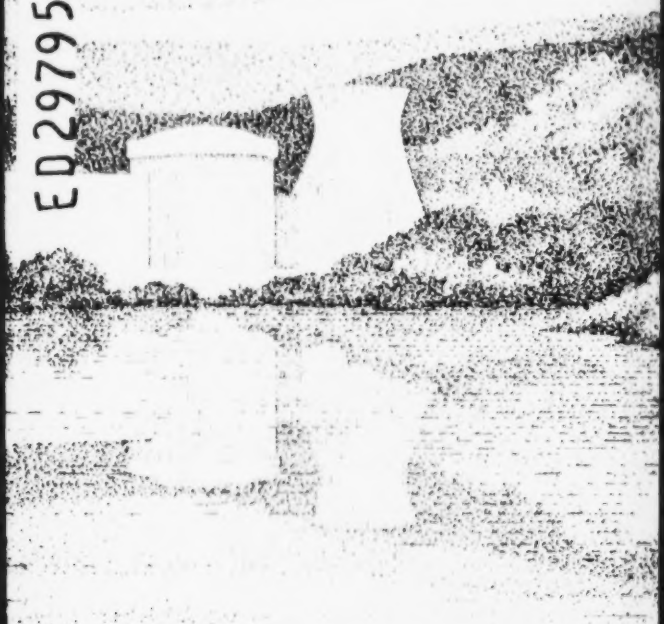

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Assistant Secretary for
Nuclear Energy
Office of Support Programs

OPERATIONAL SAFETY refers to powerplant systems and procedures that ensure the day-to-day health and safety of those in and around the plant. Operational safety of a nuclear powerplant is the result of careful planning, good engineering and design, strict licensing and regulation, and thorough environmental monitoring.

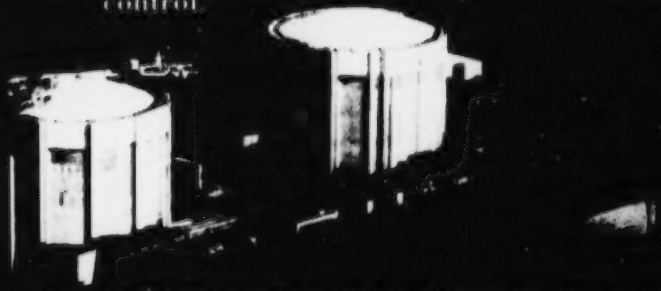
plants is assured by the following procedures:

- Reactor operators are thoroughly trained and constantly updated on procedures of powerplant operation.

- Strict security is maintained at the powerplant at all times.

- The amount of radiation routinely released by nuclear powerplants is so small that it cannot be measured against the natural radiation present in the environment.

- To ensure worker safety, the radioactive spent (used) fuel is stored in deep pools of water within the powerplant in order to allow cooling. The spent fuel is handled by remote control.



- The Nuclear Regulatory Commission (NRC) certifies that the powerplant is designed, constructed, and operated in a safe manner.

- Ongoing inspections and environmental monitoring programs ensure that nuclear powerplants comply with all requirements for public health, safety, and environmental protection.

OPERATIONAL SAFETY OF NUCLEAR POWERPLANTS

All energy systems have some impact on the environment and the people living around the plant. Nuclear powerplants use steam to produce electricity just as coal and other fossil-fueled powerplants do, so certain aspects of operational safety are common to both types of plants. These include worker safety around high-pressure steam lines, heat releases to the environment, and precautions necessary with high-voltage electricity. In addition, each technology has its own set of special concerns. Isolating radiation, training reactor operators, and maintaining strict security around a nuclear powerplant are examples of some of the operational safety issues associated with nuclear energy.

It is recognized that even the best designed and constructed powerplant cannot meet the necessary high safety standards unless it is operated and maintained by skilled personnel. To meet the strict standards governing nuclear powerplants, activities that affect the well-being of the people or the environment around the plant are constantly monitored. Inspections are made to assure that the high quality and careful design of all the safety systems are maintained throughout the life of the powerplant. Any problems or questions encountered during operations, inspection, or testing are reported, and corrective actions are taken.

PERSONNEL TRAINING PROGRAMS

A vital part of operational safety is the intensive training and preparedness of the people who operate the powerplant. To train operators, utilities use sophisticated powerplant simulators—exact mockups of the control room of a real powerplant. The simulators are computer controlled, allowing the operators to gain practical experience in managing all types of normal and unusual occurrences without any danger to the public or the environment. Accidents can be simulated at actual, fast, or slow speed. The instructors also have the ability to stop an "accident" and discuss with the student operators the correct actions to take.

Simulated control rooms are used to train powerplant operators.

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The importance of training reactor operators was highlighted by the accident at Three Mile Island (TMI). This accident, which occurred in March 1979, focused public attention on the question of operator training. A minor mechanical malfunction was compounded by incorrect actions taken by the reactor operators. Although no one was injured by the accident, the financial costs have been enormous. As a result of the TMI accident, recruitment, training, and operating standards have been raised. Training now focuses more on understanding the necessary actions and the reasoning behind those actions. The Institute of Nuclear Power Operations (INPO), an independent organization sponsored by the utility industry, conducts detailed evaluations of operating practices at nuclear powerplants. The U.S. Department of Energy (DOE), INPO, and the NRC are working together to improve the expertise of reactor operators. The already high standards for staffing, training, and selection of the people who operate nuclear powerplants have been further upgraded as a result of recommendations from these groups.

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THERE ARE THREE BASIC CATEGORIES OF REACTOR OPERATORS:

Licensed Senior Reactor Operators are the most experienced of all the reactor operators. They direct the activities of the other operators in the plant and have passed advanced tests given by the NRC.

Licensed Reactor Operators actually operate the reactor and have completed detailed academic and technical training programs.

Unlicensed Plant Operators work on the equipment in the plant that is not nuclear-related.

Each working shift at a nuclear powerplant is now required to have on duty at least one Licensed Senior Reactor Operator, two Licensed Reactor Operators, and two Plant Operators. New regulations also require that this team be supported by a technical advisor. The technical advisors, who are usually graduate engineers, provide advanced technical assistance and information during both normal and unusual operating conditions.

New NRC regulations require all reactor operator trainees to achieve higher test scores than were previously acceptable. All licensed operators are required to complete periodic retraining courses to keep their skills at the highest levels. This retraining consists of classroom lectures, drills, on-shift discussions, and exercises with a reactor control room simulator. These stricter standards make it more difficult to become a reactor operator and improve the technical competence of those who do become operators.

NUCLEAR POWERPLANT SECURITY

Because the by-products of the nuclear fission process are potentially harmful, strict security is required at nuclear powerplants. Security is maintained not only to protect the plant and the people in and around it, but also to limit the possibility of the theft of any nuclear materials. Each utility company operating a nuclear powerplant must develop a "safeguards contingency plan," a written plan of what would be done in case of threats, thefts, or sabotage. Periodic exercises and drills are conducted to assure that all personnel know what to do in case of an emergency. Not only are the plants designed to be secure against outside threats, but they are also equipped and operated in a manner to make them secure against internal threats. Access to the plant and its surrounding property is restricted by a series of boundaries.

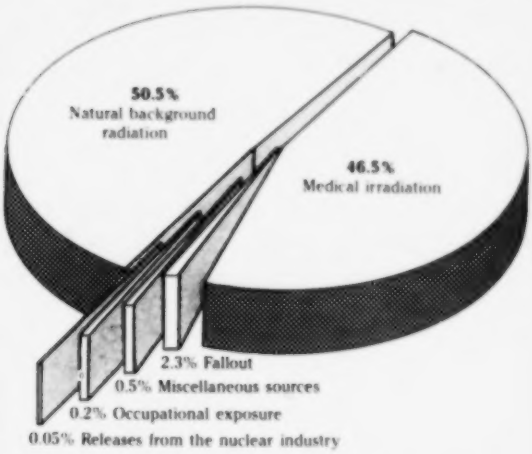
Security procedures at nuclear powerplants are strictly regulated.

Each boundary represents a barrier that will detect any intrusion and allow time for emergency response. A well-trained security force, physical barriers, electronic surveillance, and screening of plant visitors are all used to keep unauthorized persons from entering the plant site. These security procedures are strictly regulated by the NRC.

CONTROL OF RADIATION RELEASES

Each utility company that applies for a nuclear powerplant construction permit must demonstrate that the plant can operate within the NRC's radiation exposure limits. Once the permit is approved and the plant is built, continuous monitoring by the utility company and periodic inspections by the NRC provide assurance that the plant is being operated safely.

SOURCES OF RADIATION TO U.S. POPULATION



The nuclear energy industry contributes far less than 1 percent of the average person's exposure to radiation.

Source: National Academy of Sciences, 1980; National Council of Radiation Protection and Measurement, 1984

Radiation's biological effect is measured in units called rems. However, measuring radiation from powerplants in rems is like measuring the dimensions of a desk top in miles. It can be done, but it isn't very practical. For that reason, the most commonly used unit to measure the radiation emitted by a powerplant is the millirem (1 rem equals 1,000 millirem).

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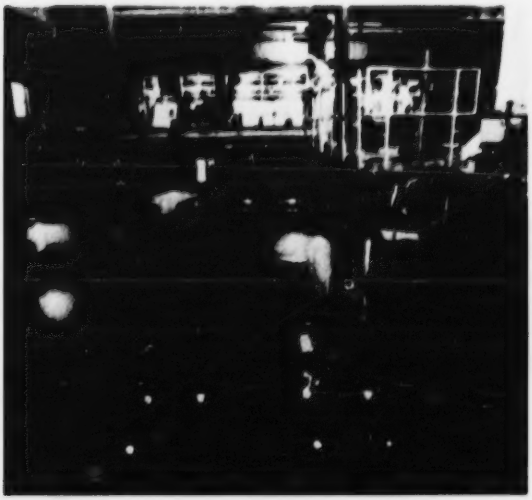
The average American receives approximately 200 millirem of radiation each year from many sources. Natural radiation accounts for about 100 millirem, and medical uses account for almost all of the remaining exposure. The NRC regulations specify 5 millirem as the maximum allowed annual exposure to a person living beside a nuclear powerplant. In fact, today's nuclear powerplants expose their neighbors to far less than 1 millirem per year.

AVERAGE RADIATION EXPOSURE

About half of the radiation received by the average American comes from the Earth's soil, cosmic rays from the sun and outer space, and natural radioactive elements in air, food, and water. A little less than half comes from medical uses and treatment, and a very small fraction comes from other miscellaneous sources. By comparison, less than one-tenth of 1 percent of the average American's exposure to radiation is from the nuclear powerplant industry.

SPENT FUEL—HANDLE WITH CARE

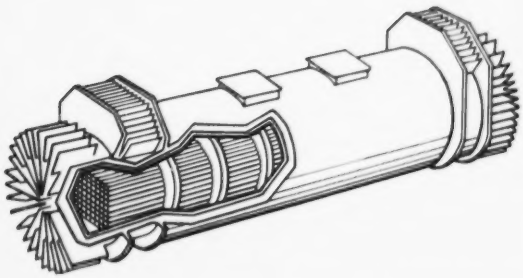
In order for a nuclear powerplant to continue to operate efficiently, part of its nuclear fuel must be periodically replaced. Special care is taken in handling this highly radioactive material, which is called spent fuel. Each year the reactor is shut down, and the top of the reactor vessel is removed. About one-third of the fuel is then removed from the reactor by remote control and transferred to a 30-foot-deep pool of water within the powerplant. This water serves as a radiation shield and a means of removing heat from the spent fuel. Although this is considered temporary storage, some spent (used) fuel has been held safely this way for more than 30 years.



A temporary storage pool cools spent fuel and also shields workers from radiation.

Much research has been devoted to developing a method to recycle spent fuel. "Reprocessing" is the technology that removes the desirable materials for use as fuel in other nuclear reactors, while preparing the remaining waste for permanent disposal. A commercial reprocessing plant was operated in the United States between 1966 and 1972, and successfully accomplished these objectives. In 1977, the Federal Government decided to delay commercial reprocessing, but the technology is available today.

The major focus of research on the disposal of spent fuel is the development of a permanent method of waste storage. Ongoing Government studies have determined that the best location will be underground in deep, dry, and stable formations. Salt domes, granite, limestone, and shale are all being considered. The waste storage facility would consist of a number of chambers excavated at a depth of 2,000 feet or more. Sealed, corrosion-resistant cylinders have been designed to contain the waste and reduce the possibility of releasing any radioactive material. However, even if a release should occur in these deep, dry formations, it would take thousands of years for the material to reach any living organisms. By that time virtually all of the radioactivity would be gone. The waste will be retrievable by conventional mining techniques if even better methods of disposal are developed in the future.



The shipping casks for spent fuel weigh as much as 25 tons and are built to withstand major accidents, such as collision and fire.

Disposal of spent fuel will necessarily involve shipping from one point to another. Strict regulations govern the safe transportation of nuclear material. It is no more hazardous to ship spent fuel and radioactive wastes than to ship many other materials that are routinely transported all over the country. The types of hazards in the transportation of nuclear fuel include theft and the accidental release of radioactive material due to a collision. All shipments are subject to strict Federal regulations. Heavy-duty shipping materials and highly trained security personnel are used to prevent theft. Shipping containers have been developed and tested that far exceed the safety standards for transportation of other toxic substances. The shipping casks have been deliberately subjected to violent, high-speed collisions. In all these tests, the damage sustained by the shipping casks would not have permitted the release of any radioactivity.

THE ROLE OF THE NUCLEAR REGULATORY COMMISSION

The NRC was established in 1974 by the Energy Reorganization Act and took over the regulatory functions of the Atomic Energy Commission. The NRC has four basic functions: licensing, inspection and enforcement, standards development, and regulatory research. Of these functions, the first two are directly related to operational safety.

The licensing process is the responsibility of the NRC's Office of Nuclear Reactor Regulation. A detailed licensing and review process ensures that nuclear powerplants are built and operated within the guidelines of strict regulations at the Federal, State, and local levels. This process involves numerous review boards consisting of both technical experts and local citizens. The licensing process includes holding hearings, conducting studies, and filing reports. The entire process is performed twice—first to obtain a construction permit and then later to obtain an operating permit. The detailed licensing process ensures that before a plant is constructed, the utility has the expertise to build and operate the powerplant in a safe manner.

The NRC's Office of Inspection and Enforcement assures that nuclear powerplants comply with all requirements for public health and safety, environmental protection, and security of nuclear materials and facilities. This office

The NRC performs periodic inspections of nuclear powerplants to ensure that the facility is being operated in compliance with Federal regulations.

measures emissions of radiation from nuclear powerplants to check the accuracy of the measurements reported by the operating utility company. This office also investigates any accidents or unusual incidents, or even allegations of unusual occurrences, that may occur during operation of a powerplant. The NRC enforces safety by notifying the operating utility of violations requiring corrective actions, imposing heavy fines, or even suspending or revoking the operating license.

OPERATIONAL SAFETY— A CONTINUING COMMITMENT

A utility company planning to build a nuclear powerplant has the task of assuring the public that the plant will be built and operated safely. In recent years, the Government has further upgraded the already strict requirements for these powerplants. More attention to safety and potential environmental effects has been given to the nuclear energy industry than to any other energy-related technology. This careful approach has resulted in the development of an important energy source with an exceptional safety record.

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